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Hemithecium hainanense sp. nov. and a checklist and key to *Hemithecium* species from China

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Abstract—*Hemithecium hainanense* from Hainan Island, China, is described as new to science. The lichen is characterized by erumpent lirellae with a lateral to complete thalline margin, large transparent transversely septate ascospores, and the presence of norstictic acid. *Hemithecium chlorocarpum* is reported as a new record from China. A checklist and key to *Hemithecium* species from China are presented.

Key word—*Ascomycota, Graphidaceae, Ostropales, Ostropomycetidae,* taxonomy

Introduction

The lichenized fungal genus *Hemithecium* Trevis. (*Graphidaceae*, *Ostopales*) has been recently revised (Staiger 2002; Staiger et al. 2006; Lücking et al. 2008; Rivas Plata et al. 2012, 2013; Lumbsch et al. 2014; Miadlikowska et al. 2014). The genus is characterized by its crustose thalli, lirelliform apothecia, well-developed convergent labia, concealed discs, non-carbonized exciples, simple paraphyses, and hyaline transversely septate or muriform ascospores.

Hemithecium contains about 50 species worldwide (Staiger 2002, Upreti et al. 2011, Sharma et al. 2012). Miao et al. (2007) reported three species of *Hemithecium* (*H. chapadanum*, *H. chlorocarpoides*, and *H. chrysenteron*) as new records from China, which Lücking et al. (2008) since placed in the invalid genus "*Pallidogramme*". During the compilation of the Flora Lichenum Sinicorum, five *Hemithecium* species were recognized in China (Jia et al. 2011, Jia & Wei 2016). Here, we describe a new species, *Hemithecium hainanense*, and add a new Chinese record, *H. chlorocarpum*.

Materials & methods

The specimens are deposited in the Herbarium Mycologicum Academiae Sinicae – Lichenes, Beijing, China (HMAS-L) and the Lichen Herbarium of the College of Life Sciences, Liaocheng University, Liaocheng, China (LCU-L). Morphological and anatomical features were examined using an Olympus SZX12 dissecting microscope and Olympus BX51 & Nikon Eclipse-55i light microscopes. Measurements and illustrations were taken from the hand cut cross-sections of fruit bodies in tap water. Amyloidity of the ascospores was tested using Lugol's solution. The thallus surface and thin thallus sections were spot tested with K (KOH, 20%), C (saturated solution of NaOCl), and P (ethanol solution of p-phenylenediamine, 5%) reagents. The lichen substances were detected and identified by thin-layer chromatography (TLC; Culberson & Kristinsson 1970, Culberson 1972, White & James 1985).

Taxonomy

Hemithecium hainanense Z.F. Jia, **sp. nov.** Pl. 1

Fungal Name FN570071

Differs from *Hemithecium implicatum* by its longer ascospores and presence of norstictic acid.

Type: China. Hainan Province, Changjiang County, Mt. Bawangling, Yajia, 19°14′N 109°26′E, alt. 800 m, on bark, 10/V/2008, J. Li HN081472 (**Holotype**, HMAS-L 127460).

Etymology: The specific epithet *hainanense* is derived from the type locality, *Hainan*, and *-ense*, Latin, place of origin.

Thallus corticolous, crustose, pale to grayish white, thin, slightly smooth, tightly attached to the substratum, lacking isidia and soredia.

Apothecia lirelliform, numerous, elongate, simple, rarely branched, erumpent, not striate, 1–4 mm long, 0.1–0.2 mm wide, covered by lateral to complete thalline margin; disc concealed, with slit-like appearance; proper exciple conspicuous, convergent, uncarbonized, yellowish to brown; hymenium clear, 110–180 μm high, I–, with brownish epihymenium; hypothecium brownish, 5–15 μm high. Paraphyses simple, 1–2 μm wide. Asci clavate, 90–130 × 15–20 μm, 6–8-spored. Ascospores hyaline, surrounded by a thin halo, narrowly ellipsoidal, transversely septate, with 17–20 locules, 50–100 μm long and 6.5–10 μm wide, I+ violet.

Chemistry: K+ red, C–, P+ yellow; norstictic acid present (TLC).

Substrate: on bark.

Additional specimens examined: **China. Hainan Province,** Changjiang County, Mt. Bawangling, alt. 800 m, 10/V/2008, J. Li HN081467 (HMAS-L 127462), HN081470 (HMAS-L 127461); Qiongzhong County, Mt. Limushan, alt. 650 m, 25/IX/2009, B. Gao HN080910 (HMAS-L 127464), J. Li HN081236 (HMAS-L 127463); Ledong County, Mt. Jianfengling, alt. 900 m, M. Liu HN09414 (HMAS-L 115510).

Ecology & distribution: *Hemithecium hainanse* is known from altitudes of 650–900 m in a tropical rainforest on Hainan Island in southern China where

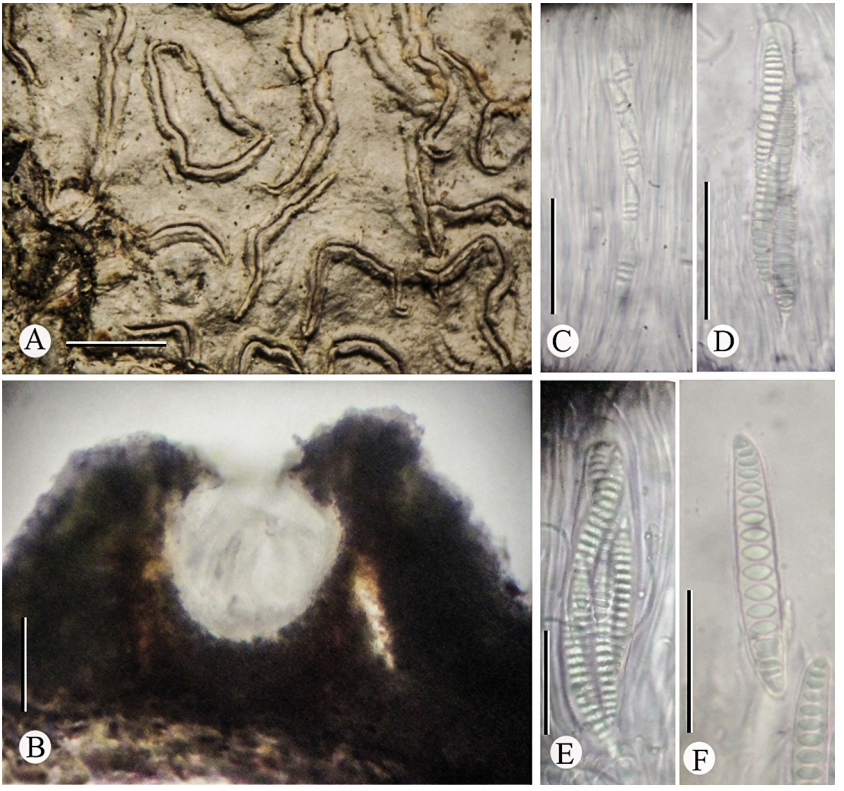

Plate 1. ***Hemithecium hainanense*** (holotype, HMAS-L 127460). A. Thallus on bark; B. Cross section of apothecium; C–E. Asci containing ascospores (showing the process of ascospore development and maturation); F. Mature ascospores. Scale bars: A = 1 mm; B = 100 μm; C–F = 50 μm.

it grows on smooth bark in moist and humid places. Associated lichen species include *Diorygma hieroglyphicum* (Pers.) Staiger & Kalb, *Graphis hossei* Vain., *G. japonica* (Müll. Arg.) A.W. Archer & Lücking, "*Pallidogramme chrysenteron*" (Mont.) Staiger et al., and other members of the *Graphidaceae*.

Remarks: *Hemithecium hainanense* is characterized by simple and sparsely branched erumpent lirellae with a lateral to complete thalline margin, a concealed disc, an uncarbonized exciple, a clear hymenium, transversely septate ascospores of 50–100 × 6.5–10 μm, and the presence of norstictic acid. The new species resembles *Hemithecium implicatum* but is distinguished from the latter by the larger transversely septate ascospores and the presence of norstictic acid.

Hemithecium balbisii (Fée) Trevis., Spighe e Paglie: 13 (1853).

Thallus corticolous, greenish-gray, upper surface waxy. Apothecia lirelliform, 2–8 mm long, 0.3–0.4 mm wide, sometimes branched, covered partly by the cream-colored, indistinctly crenate thalline margin. Discs concealed. Proper exciple convergent, pale to brown. Hymenium clear, 80–90 μm high. Ascospores 8/ascus, hyaline, elongate, muriform, 10–12 × 2–4-locular, 28–50 μm long and 10–15μm wide, I+ violet, lacking a surrounding halo.

Chemistry: K–, C–, P–; no substances present (TLC).

Substrate: on bark.

Specimens examined: **CHINA. Fujian Province**, Wuyishan City, Mt. Wuyishan, alt. 540 m, 27/V/2007, J. Li FJ502 (LCU-L). **Hainan Province**, Baoting County, Mt. Qixianling, alt. 200 m, 23/VII/2009, J. Li HN240-1 (HMAS-L 125725); Ledong County, Mt. Nanlimu, alt. 180 m, 22/VII/2009, M. Liu HN09357 (HMAS-L 115556). **Yunnan Province**, Honghe City, Mt. Daweishan, alt. 900 m, 23/IX/2011, Z.F. Jia 11-455 (LCU-L); 1250 m, 23/IX/2011, Z.F. Jia 11-508-3 (LCU-L).

Remarks: The species is similar in appearance to "*Pallidogramme chlorocarpoides,*" which differs by its larger, brown ascospores and its production of stictic acid. *Hemithecium balbisii* was previously reported from an unstated locality in China as *Graphis balbisii* Fée (Krempelhuber 1868; Wei 1991). A pantropical species, *H. balbisii* also occurs in South America (Staiger 2002).

Hemithecium canlaonense (Vain.) A.W. Archer, Syst. Biodiv. 5: 17 (2007).

Thallus corticolous, gray to greenish-gray, upper surface waxy. Apothecia lirelliform, 1–3 mm long, 0.2–0.3 mm wide, sometimes branched, covered partly by the indistinctly crenate thalline margin. Discs concealed. Proper exciple convergent, pale to brown. Hymenium clear, 80–110 μm high. Ascospores 8/ascus, hyaline, ellipsoidal, transversely septate, 4-locular, 15–25 μm long and 8–14 μm wide, I–, lacking a surrounding halo.

Chemistry: K–, C–, P–; no substances present (TLC).

Substrate: on bark.

Specimens examined: **CHINA. Guizhou Province**, Tongren City, Mt. Fanjingshan, alt. 133 m, on bark, 16/IX/1963, J.C. Wei 0762 (HMAS-L 047793), 0763 (HMAS-L 047790).

Remarks: The species is similar to *H. oshioi*, but differs by its smaller ascospores and the absence of stictic acid. *Hemithecium canlaonense* was previously reported in China as *Fissurina canlaonensis* (Vain.) Staiger (Meng et al. 2011). This pantropical species also occurs in Indonesia and the Philippines (Archer 2007) and in India (Patwardhan & Kulkarni 1976; Sharma et al. 2012) where it was recorded as *Fissurina canlaonensis*.

Hemithecium chlorocarpum (Fée) Trevis., Spighe e Paglie : 12 (1853).

Thallus corticolous, pale gray to greenish-gray, surface smooth. Apothecia lirelliform, 1–4 mm long, 0.2–0.4 mm wide, sometimes branched, covered partly by the distinctly crenate, thalline margin. Discs concealed. Proper exciple convergent, pale to brown. Hymenium clear, 150–180 μm high. Ascospores 1/ascus, hyaline, ellipsoidal, muriform, 20–30 × 5–8-locular, 85–125 μm long and 18–27.5 μm wide, I+ violet, lacking a surrounding halo.

Chemistry: K–, C–, P–; no substances present (TLC).

Substrate: on bark.

Specimen examined: **China. Hainan Province**, Wuzhishan City, Mt. Wuzhishan, alt. 750 m, on bark, 28/VI/2001, J.B. Chen 20657 (HMAS-L 076854)

Remarks: The species resembles *Hemithecium balbisii*, but differs by its larger ascospores and asci containing one ascospore. *Hemithecium chlorocarpum* is here reported as new to China. As a pantropical element, it also occurs in South America (Staiger 2002).

Hemithecium duomurisporum Z.F. Jia, Mycosystema 30: 871 (2011).

Thallus corticolous, grayish to olive-green, smooth. Apothecia lirelliform, 2–8 mm long and 0.3–0.5 mm wide, rarely branched, covered partly by the slightly crenate thalline margin. Discs concealed. Proper exciple convergent, yellow-brown. Hymenium clear, 150–180 μm high. Ascospores 1/ascus, hyaline, lacking a surrounding halo, elongate, muriform, with 20–22 × 3–9-locular with the traverse septa doubled, 100–140 μm long and 20–29 μm wide, I+ violet.

Chemistry: K+ yellow, C–, P+ orange; stictic acid present (TLC).

Substrate: on bark.

Specimens examined: **China. Hainan Province**, Wuzhishan City, Mt. Wuzhishan, alt. 640 m, 20/VII/2009, M. Liu HN09318 (HMAS-L 115536); alt. 680 m, 28/IX/2008, Z.F. Jia HN0080706 (HMAS-L 127486). Qiongzhong County, Mt. Limushan, 750 m, 25/XI/2008, J, Li HN081229 (HMAS-L 126329).

Remarks: This species is characterized by the large muriform ascospores and presence of stictic acid. It is similar to *H. chlorocarpum*, which differs by its smaller ascospores and its lack of lichen substances (see the description above). *Hemithecium duomurisporum* was previously recorded from Hainan, China (Jia et al. 2011).

Hemithecium implicatum (Fée) Staiger, Biblioth. Lichenol. 85: 287 (2002).

Thallus corticolous, greenish, slightly smooth. Apothecia lirelliform, 1–5 mm long and 0.1–0.2 mm wide, often branched, covered partly by the

indistinctly crenate thalline margin. Discs concealed, with slit-like appearance. Proper exciple convergent, yellowish to brown. Hymenium clear, 100–150 µm high. Ascospores 2–8/ascus, hyaline, lacking a surrounding halo, elongate, transversely septate with 15–23 locules, 35–80 µm long and 5.5–9 µm wide, I+ violet.

Chemistry: K–, C–, P–; no substances present (TLC).

Substrate: on bark.

Specimens examined: **CHINA. Hainan Province**, Ledong County, Mt. Jianfengling, 900–950 m, 26–28/VII/2009, J. Li HN09127 (HMAS-L 115454), HN09128 (HMAS-L 115437), HN09218 (HMAS-L 115502); Changjiang County, Mt. Bawangling, 880 m, 25/X/2008, J. Li HN081456 (HMAS-L 117055), HN081477 (HMAS-L 126330), HN081478 (HMAS-L 126298); Qiongzhong County, Mt. Limushan, 650 m, 25/IX/2008, J. Li HN081237 (HMAS-L 117096), HN081465 (HMAS-L 117097); Wuzhishan City, Mt. Wuzhishan, 680 m, 20/VII/2009, J. Li HN09064 (HMAS-L 115475), HN204 (HMAS-L 117067).

Remarks: This species is similar in appearance to *H. oshioi*, which is distinguished by its shorter ascospores and its production of lichen substances (see the description below). *Hemithecium implicatum* also occurs in Mexico (Wirth & Hale 1963, as *Graphis implicata*) and Brazil (Staiger 2002).

Hemithecium oshioi (M. Nakan.) M. Nakan. & Kashiw., Bull. Natl. Sci. Mus. Tokyo, B 29(2): 88 (2003).

Thallus corticolous, grayish, rough. Apothecia lirelliform, 0.5–3 mm long and 0.2–0.4 mm wide, rarely branched, covered partly by the indistinctly crenate thalline margin. Discs concealed. Proper exciple convergent, yellowish to brown. Hymenium clear, 90–120 µm high. Ascospores 2–6/ascus, hyaline, lacking a surrounding halo, elongate, with 5–9 transverse septa, 25–40 µm long and 5.5–8 µm wide, I+ violet.

Chemistry: K+ red, C–, P+ yellow; norstictic acid present (TLC).

Substrate: on bark.

Specimen examined: **CHINA. Fujian Province**, Jianou City, Fangdao Town, Wanmulin, 310 m, 3/VI/2007, Q.F. Meng FJ925 (LCU-L). **Hainan Province**, Wuzhishan City, Mt. Wuzhishan, 700 m, 21/VII/2009, J. Li HN09092 (HMAS-L 115471); 670 m, 28/IX/2008, T. Zhang HN080346 (HMAS-L 125726). Ledong County, Mt. Jianfengling, 850 m, 29/VII/2009, Z.F. Jia HNJ63 (HMAS-L 128787), HNJ64 (HMAS-L 128786).

Remarks: This species is similar to *H. laubertianum*, which differs by its thick-walled spores and its lack of lichen substances (Staiger 2002). *Hemithecium oshioi* was reported from Zhejiang, China (as *Graphis oshioi* M. Nakan.: Wu & Qian 1989, Wei 1991) and Hainan, China (Jia et al. 2011, Wei et al. 2013). It is also recorded from Japan (Nakanishi 1966, as *Graphis oshioi*).

Key to species of *Hemithecium* from China

1. Ascospores with transverse septa 2
1. Ascospores muriform 5
2. Ascospores 4-locular, 15–25 × 8–14 µm . . . . . ***H. canlaonense***
2. Ascospores >4-locular, >25 µm long 3
3. No substances present; ascospores 15–23-locular, 35–80 × 5.5–9 µm ***H. implicatum***
3. Norstictic acid present 4
4. Ascospores 17–20-locular, 50–100 × 6.5–10 µm . . . . . ***H. hainanense***
4. Ascospores 6–10-locular, 25–40 × 5.5–8 µm . . . . . ***H. oshioi***
5. Stictic acid present; ascospores 100–140 × 20–29 µm . . . . . ***H. duomurisporum***
5. No substances present **6**
6. Ascospores 28–50 × 10–15 µm . . . . . ***H. balbisii***
6. Ascospores 85–125 × 18–27.5 µm . . . . . ***H. chlorocarpum***

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